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REMARKS

Claims 1, 5-20, 24-26, 50-57, 66-74 and 76-84 were pending for the first Office Action dated February 6, 2003. Each of the claims stands rejected under various grounds. The Office Action and the cited references have been carefully considered. In light of the amendments presented above and the following remarks, reconsideration and allowance of the subject application are hereby requested.

Claims 10, 11, 14, 16, 17-19, 24-26, 50-54, 66, 69-72, 74, 76-78 and 81-84 stand rejected under 35 U.S.C. §102(b) as being anticipated by European Patent Application No. 0 841 406 A1. Additionally, claims 1, 5-9, 12, 13, 15, 20, 52-57, 67, 68, 73 and 79 stand rejected under 35 U.S.C. §103(a) as being unpatentable over European Patent Application No. 0 745 694 A1.

Independent Claim 1

As discussed in Applicant's previous response, the '406 patent is directed to a method of shaping semisolid metals and teaches two specific methods for generating crystal nuclei (i.e., crystallizing the liquid alloy): 1.) via the use of an agitation source such as a vibrating jig, or 2.) via the use of a grain refiners such as Ti or B. (*See e.g.*, page 6, lines 37-43, page 6, lines 53-56, page 10, lines 1-3). As also discussed in Applicant's previous response, the '694 patent also teaches specific methods for crystallizing the liquid alloy, including: 1.) pouring the liquid alloy down a cooling jig 20 to agitate and quickly cool the liquid alloy M (Figure 3), 2.) using a mechanical agitation source such as a vibrating jig, or 3.) adding a grain refiners to the liquid alloy such as Ti or B.

On page 5 of the Office Action (referring to Figure 3 of the '406 application), it is stated that: "The vibrating rod is only used at the beginning to crystallize the metal, but during step 3, there were no vibration involve as shown. Therefore, [the '406 patent] discloses the claimed invention as claimed." The Applicant respectfully disagrees with this assertion for at least the following reasons. Independent claim 1 recites that crystallization of the metallic melt occurs "without the use of a grain refiner and without mechanical agitation". Since the '406 application expressly and positively discloses the use of a vibrating rod at some point during the process of crystallizing the metal, regardless of any subsequent step that might be performed during the semi-solid forming process that does not involve the use the vibrating rod, mechanical agitation has in fact been used to crystallize the metal. Indeed, as disclosed in the '406 application, agitation of the metal is an important aspect in the crystallization process, and just because such agitation is discontinued at some point during the crystallization process does not in any way minimize it's importance to the overall forming process.

Notably, the process recited in independent claim 1 does not require any form of mechanical agitation at any point during the crystallization stage. Accordingly, it can not fairly be said that the teachings of the '406 application anticipate independent claim 1. Nevertheless, the Applicant has amended independent claim 1 to further distinguish over the '406 application by specifically reciting that mechanical agitation is not used <u>at any point</u> during the crystallization phase of the forming process. For at least the forgoing reasons, the Applicant submits that independent claim 1, as amended, is clearly distinguishable over the

'406 and '694 applications and any of the other art of record, whether considered along or in combination. Accordingly, withdrawal of the rejection of independent claim 1 is respectfully requested.

Dependent Claims 5-9, 11-20, 24-26 and 76

In addition to the reasons supporting the patentability of independent base claim 1, further reasons support the patentability of the claims depending therefrom. For example, dependent claim 8 recites that the regulating further includes transferring the metallic melt into the vessel at a selected vessel temperature, and dependent claim 9 further recites that the selected vessel temperature is between about 606 degrees Celsius and about 610 degrees Celsius. On page 5 of the Office Action, it is stated that "the temperature of the metal would reflect on the temperature of the vessel." However, the Applicant respectfully points out that the increase in the temperature of the vessel by the metal occurs after transferring of the metal into the vessel. The '406 and '694 applications fail to disclose that the temperature of the vessel 30 is in any way regulated to provide a selected temperature prior to transferring of liquid metal into the vessel 30. (*See e.g.*, Figures 3 and 13 in the '406 application and Figures 3 and 29 in the '694 application). Nevertheless, the Applicant has amended dependent claim 8 to further distinguish over the '406 and '694 applications by specifically reciting that the regulating includes "preheating of the vessel to a selected vessel temperature prior to transferring the metallic melt into the vessel". Accordingly, the Applicant submits that dependent claims 8 and 9 are clearly distinguishable over both the '406 and '694 applications.

Dependent claim 16 recites that the regulating includes controlling a differential between

the temperature of the metallic melt during the heating and the temperature of the metallic melt during the transferring, and dependent claim 17 further recites that the regulating includes controlling a drop in temperature of the metallic melt during the transferring of the metallic melt into the vessel. Once again, the Applicant submits that these features are neither taught nor suggested by the '406 and '694 applications. While the '406 and '694 applications appear to disclose a preferred heating temperature range of the molten metal and a preferred temperature range of the molten metal prior to being charged into the vessel, there is no indication or suggestion regarding providing control over the temperature differential between the molten metal during the heating stage and the transferring stage. Likewise, the '406 and '694 applications fail to disclose or suggest providing control over the temperature drop of the molten metal during its transfer into the vessel. The Applicant submits that each of these steps is associated with the "regulating" step recited in independent base claim 1 and has an impact on the production of a semi-solid material having a predetermined microstructure (e.g., rounded solid particles having a diameter no greater than 50 μm).

Further, dependent claim 24 recites that the temperature-controlled vessel is a shot sleeve of a semi-solid forming press. Dependent claim 25 further recites that the semi-solid material is injected from the shot sleeve (i.e., the temperature-controlled vessel) directly into a die mold. Referring to Figures 3 and 13 in the '406 application, the forming vessel 30 is clearly separate and disassociated from the injection sleeve 50, 180. Similarly, referring to Figures 3, 29, etc. in the '694 application, the forming vessel 30 is clearly separate and disassociated from the injection sleeve 40, 70. Indeed, nowhere in the '406 application or the '694 application is it

taught or even suggested that the functions associated with the vessel 30 (e.g., receiving the liquid alloy and controlling the cooling rate of the liquid alloy) and the injection sleeve 40, 50, 70, 180 (e.g., injecting the semisolid material into a mold to form a part) are incorporated into the same structure such that the semi-solid material may be injected directly into a die mold. Moreover, nowhere in the '406 application or the '694 application is taught or even suggested that the temperatures of the injection sleeve 40, 50, 70, 180 is in any way controlled.

Notably, with regard to the '406 and '694 applications, the semisolid material must be transferred from the forming vessel into the injection sleeve and then from the injection sleeve into the mold. As should be appreciate, this added process step requires additional time, thereby increasing processing time. Additionally, the added step of discharging the semisolid material from the vessel into the injection sleeve increases the likelihood of contaminants being incorporated into the semisolid material, and may also effect the temperature of the semisolid material prior to injection into the mold, which may in turn have a negative effect on material microstructure. Accordingly, it is respectfully submitted that dependent claims 24 and 25 are clearly distinguishable over the subject matter disclosed in the '406 and '694 applications.

Dependent claim 76 recites that the vessel includes a plurality of heat transfer zones, and that the cooling of the metallic melt at the controlled rate comprises independently controlling the temperature of the metallic melt disposed adjacent each of the heat transfer zones. These features are illustrated, for example, in Figure 9 of the subject application, wherein the vessel 80 is equipped with two independently-controlled heat transfer zones 102a, 102b. As should be appreciated, providing multiple heat transfer zones provide a greater

degree of control over the cooling rate of the metallic melt throughout the entire vessel, thereby producing a material with superior characteristics (e.g., small diameter rounded particles) and a more homogenous material microstructure. Notably, the vessels disclosed in the '406 and '694 applications fail to disclose or even suggest the features and characteristics recited in dependent claim 76 (e.g., a plurality of heat transfer zones for independently controlling the temperature of the metallic melt adjacent the each of the heat transfer zones).

Independent Claim 10

As discussed in Applicant's previous response, with regard to the '406 application, and as illustrated in Figures 3, 13, etc., even assuming arguendo that the ladle 10 could be considered a holding vessel and that the vessel 30 is a forming vessel, there is no indication or even a suggestion that the temperature of the liquid metal contained within the ladle 10 is "controllably adjusted to a selected transfer temperature", as recited in independent claim 10. Instead, the temperature of the molten metal within the ladle 10 is subjected to uncontrolled ambient cooling. Indeed, the '406 application fails to disclose or even suggest that the ladle 10 controllably adjusts the temperature of the molten metal in any manner whatsoever prior to transferring the liquid metal to the vessel 30. Although independent claim 10 has been rejected as being anticipate by the '406 application, there is no reasoning set forth in Office Action as to how each of the requirements of independent claim 10 are satisfied by the teachings of the '406 application, particularly with regard to the above-discussed feature associated with transferring of the metallic melt into a holding vessel and controllably

adjusting the temperature of the metallic melt in the holding vessel to a selected transfer temperature.

For at least the forgoing reasons, the Applicant submits that independent claim 10 is clearly distinguishable over the '406 application and any of the other art of record, whether considered along or in combination. Accordingly, withdrawal of the rejection of independent claim 10 is respectfully requested.

Independent claim 50

Independent claim 50 recites, among other features, the feeding of the semi-solid material from the temperature-controlled vessel directly into a mold for forming into a shaped article. As discussed above, and as clearly illustrated in Figures 3 and 13 of the '406 application, the forming vessel 30 is separate and disassociated from the injection sleeve 50, 180. As a result, the metal M_3 is not fed from the forming vessel 30 directly into the die mold 60. To the contrary, the metal M_3 is instead transferred from the forming vessel 30 into the injection sleeve 50, 180 via gravity feed, and then from the injection sleeve 50, 180 to the die mold 60. There is no indication or suggestion in the '406 application whatsoever that the metal M_3 may be transferred from the forming vessel 30 directly into the die mold 60. Indeed, the forming vessel 30 does not include any type of device or mechanism that would even allow the metal M_3 to be transferred directly into the die mold 60. Instead, the metal M_3 must be transferred from the forming vessel 30 into the injection sleeve 50, 180 (i.e., an intermediate container), followed by discharging of the metal M_3 from the injection sleeve 50, 180 into the die mold 60.

Notably, the invention claimed in independent claim 50 avoids this added handling/processing step by combining the functions associated with the vessel (e.g., receiving and controlling the cooling rate of liquid metal) and the injection sleeve (e.g., injecting the semisolid material into a mold to form a part) into a single, integrated structure such that the semi-solid material may be injected directly into a die mold. As should be appreciated, this feature can result in a significant reduction in overall processing time. Moreover, discharging the semisolid material from the temperature-controlled vessel directly into the mold substantially decreases the likelihood of contaminants being incorporated into the semisolid material. Additionally, discharging the semisolid material from the temperature-controlled vessel directly into the mold has the effect of reducing any negative effects on material microstructure that might otherwise be caused by a change in temperature of the semisolid material prior to injection into the mold.

For at least these reasons, the Applicant submits that the invention recited in independent claim 50 is distinguishable from and offers distinct advantages over the system disclosed in the '406 application. Nevertheless, the Applicant has amended independent claim 50 to further distinguish over the '406 application by specifically reciting that feeding of the semi-solid material from the temperature-controlled vessel directly into the mold is accomplished without transferring the semi-solid material to an intermediate container. As discussed above, the '406 application teaches that the metal M_3 is transferred from the forming vessel 30 into the injection sleeve 50, 180 (i.e., an intermediate container) and then into the die mold 60.

The Applicant submits that independent claim 50 is clearly distinguishable over the '406 application and any of the other art of record, whether considered along or in combination. Accordingly, withdrawal of the rejection of independent claim 50 is respectfully requested.

Dependent Claims 51-57 and 77-84

In addition to the reasons supporting the patentability of independent base claim 50, further reasons support the patentability of the claims depending therefrom. For example, dependent claim 54 recites the step of controlling the rate of displacement of the ram between about 1 inch per second and about 10 inches per second to provide non-turbulent flow of the semi-solid material into the mold. The '406 application discloses that the injection rate of the semisolid material is 0.5 meters/second, which converts to 19.7 inches/second. Accordingly, the injection rate disclosed in the '406 application falls significantly outside of the range recited in dependent claim 54. Additionally, dependent claim 83 is patentable for reasons similar to those presented above with regard to independent claim 10, and dependent claim 84 is patentable for reasons similar to those presented above with regard to dependent claim 76.

Independent claim 66

Independent claim 66 recites that crystallization of the metallic melt occurs "without the use of a grain refiner and without mechanical agitation". Additionally, the Applicant has amended independent claim 66 to further recite that mechanical agitation is not used at any point during the crystallization phase of the forming process. As discussed above, the '406

and '694 applications expressly and positively disclose the addition of a grain refiner or the use of a vibrating rod at some point during the process of crystallizing the metal.

Independent claim 66 also recites that the regulating step includes controlling a differential between the temperature of the metallic melt during the heating and the temperature of the metallic melt during the transferring. As discussed above with regard to dependent claim 16, these features are neither taught nor suggested by the art of record. While the '406 and '694 applications appear to disclose a preferred heating temperature range of the molten metal and a preferred temperature range of the molten metal prior to being charged into the vessel, there is no indication or suggestion regarding providing control over the temperature differential between the molten metal during the heating stage and the transferring stage.

Independent claim 66 further recites the step of preheating a temperature-controlled vessel to a selected vessel temperature. On page 2 of the Office Action, it is stated that "the selected vessel temperature is between about 606 to 610 degrees Celsius". Additionally, on page 5 of the Office Action, it is stated that "the temperature of the metal would reflect on the temperature of the vessel." However, as discussed above, the Applicant respectfully points out that the increase in the temperature of the vessel by the metal occurs after the transfer of the metal into the vessel. Therefore, the '406 and '694 applications fail to disclose that the temperature of the vessel 30 is in any way preheated to a selected temperature. Nevertheless, the Applicant has amended independent claim 66 to further distinguish over the '406 and '694

applications by specifically reciting that the preheating of the temperature-controlled vessel to a selected vessel occurs prior to transferring metallic melt therein.

For at least the forgoing reasons, the Applicant submits that independent claim 66 is clearly distinguishable over the '406 and '694 applications and any of the other art of record, whether considered along or in combination. Accordingly, withdrawal of the rejection of independent claim 66 is respectfully requested.

Dependent Claims 67-75

In addition to the reasons supporting the patentability of independent base claim 66, further reasons support the patentability of the claims depending therefrom. For example, dependent claim 70 recites that the preheated vessel temperature is approximately equal to the temperature of the metallic melt. Additionally, dependent claim 71 further recites the steps of holding the metallic melt in an intermediate vessel prior to the transferring and controllably adjusting the temperature of the metallic melt in the intermediate vessel to the selected transfer temperature. As discussed above with regard to independent claim 10, these features are neither disclosed nor suggested by the art of record.

CONCLUSION

Attached hereto are three (3) pages that present a marked up version of the changes made to this application by the current amendment. The first page of the three (3) attached pages is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

In view of the foregoing amendments and remarks, it is respectfully submitted that Applicant's application is now in condition for allowance with now pending claims 1, 5-20, 24-26, 50-57, 66-74 and 76-84.

Reconsideration of the present application, as amended, is respectfully requested. Timely action towards a Notice of Allowability is hereby solicited. The Examiner is encouraged to contact the undersigned by telephone to resolve any outstanding matters concerning the present application.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 1, 8, 50, 66 and 80 have been amended as follows:

1. (Three Times Amended) A method of producing a semi-solid material without stirring, comprising:

heating a metal alloy to form a metallic melt;

regulating the transfer of an amount of the metallic melt into a temperature-controlled vessel; and

crystallizing the metallic melt in the vessel by cooling the metallic melt at a controlled rate less than 0.5 degrees Celsius per second without the use of a grain refiner and without mechanical agitation at any point during the crystallizing to form a semi-solid material having a microstructure comprising rounded solid particles dispersed in a liquid metal matrix and having an average diameter no greater than about 50 μm.

8. (Twice Amended) The method of claim 1, wherein the regulating further includes preheating the vessel to a selected vessel temperature prior to transferring the metallic melt into the vessel [at a selected vessel temperature].

50. (Three Times Amended) A method of semi-solid forming a shaped article, comprising:

providing a metal alloy, a temperature-controlled vessel and a mold;

heating the metal alloy to form a metallic melt;

regulating the transfer of an amount of the metallic melt into the temperature-controlled vessel; and

crystallizing the metallic melt in the vessel by cooling the metallic melt at a controlled rate less than 0.5 degrees Celsius per second to produce a semi-solid material having a microstructure comprising rounded solid particles dispersed in a liquid metal matrix;

feeding the semi-solid material from the temperature-controlled vessel directly into the mold without transferring the semi-solid material to an intermediate container; and

forming the semi-solid material into a shaped article.

66. (Twice Amended) A method of producing a semi-solid material without stirring, comprising:

heating a metal alloy to form a metallic melt;

preheating a temperature-controlled vessel to a selected vessel temperature prior to transferring metallic melt therein;

regulating the transfer of a select amount of the metallic melt into the vessel, the regulating comprising:

transferring the metallic melt into the vessel at a selected transfer temperature and at a selected transfer rate; and

controlling a differential between the temperature of the metallic melt during the heating and the temperature of the metallic melt during the transferring; and

crystallizing the metallic melt in the vessel by cooling the metallic melt at a controlled rate without the use of a grain refiner and without mechanical agitation at any point during the crystallizing to form a semi-solid material having a microstructure comprising rounded solid particles dispersed in a liquid metal matrix.

80. (Amended) The method of claim 50, wherein the regulating includes preheating the vessel to a selected vessel temperature prior to transferring the metallic melt into the vessel, the [at a] selected vessel temperature [that is] being approximately equal to the temperature of the metallic melt.